NDAS NASA Data Acquisition Software Suite- Version 2.0

Project Introduction

Current NASA propulsion test facilities include Stennis Space Center in Mississippi, Marshall Space Flight Center in Alabama, Plum Brook Station in Ohio, and White Sands Test Facility in New Mexico. Within and across these centers, a diverse set of data acquisition systems exist with different hardware and software platforms. The NASA Data Acquisition System (NDAS) is a software suite designed to operate and control many critical aspects of rocket engine testing. The software suite combines real-time data visualization, data recording to a variety formats, short-term and long term acquisition system calibration capabilities, test stand configuration control, and a variety of data post-processing capabilities. Additionally, data stream conversion functions exist to translate test facility data streams to and from downstream systems, including customer systems. The primary design goals for NDAS are flexibility, extensibility, and modularity. Providing a common user interface for a variety of hardware platforms helps drive consistency and error reduction during testing. Also, with an understanding that test facilities have different requirements and setups, the software is designed to be modular. One program may require real-time displays and data recording; others may require more complex data stream conversion, measurement filtering, or test stand configuration management. The NDAS suite allows test facilities to choose which components to use based on their specific needs. The NDAS code is primarily written in LabVIEW, a graphical data-flow driven language. Although LabVIEW™ is a general purpose programming language, large-scale software development in the language is relatively rare compared to more commonly used languages. The NDAS software suite also makes extensive use of a new, advanced development framework called the Actor Framework. It provides a level of code reuse and extensibility that has previously been difficult to achieve using LabVIEW.

The test complexes at John C. Stennis Space Center (SSC) require reliable and accurate data acquisition in order to analyze the results of rocket engine tests. Acquisition systems include high-speed data, low-speed data, event monitoring, and video feeds. In order to obtain accurate data, routine calibrations must be performed on each channel, which can be defined as a single data stream to be collected, including the entire hardware chain from signal acquisition by a transducer to signal conditioning by an amplifier and digitization by an Analog-to-Digital converter.

Low Speed Data Acquisition System (LSDAS) is utilized to provide real time display and recording of data. This data includes both analog and discrete measurements including but not limited to transducers, transmitters, thermocouples, test stand status monitoring, and valve commands and positions. NDAS must be able to correctly process data from the sensors and convert the data to engineering units.

NDAS is a data acquisition system designed for use on all NASA test stands. It replaces the current outdated systems including but not limited to: the

Technology Transfer Logo

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Stennis Space Center (SSC)

Responsible Program:

Center Independent Research & Development: SSC IRAD

TechPort

Printed on 12/06/2022
05:47 PM UTC

For more information and an accessible alternative, please visit:
https://techport.nasa.gov/view/32754

Page 1

Stennis Data Acquisition System (SDAS), and the Digital Data Acquisition System (DDAS). Its flexibility and modularity enables it be used with any hardware at any test facility.

The NDAS project developed an architecture that would provide:

- Adaptability: Hardware abstraction layer adaptable to different acquisition systems with minimal effort,
- Modularity: Functional areas designed as separate modules to simplify maintenance and life cycle support,
- Extensibility: Displays and data output files can be customized via a standardized plug-in architecture,
- Flexibility: Innovative hierarchical and self-referential database architecture allows for flexibility to deploy to any facility,
- Unified System Configuration: The system, measurements and calibrations are managed and configured within a common user interface, and
- Streamlined Operations: Run-time processing and analysis minimizes post-test data processing turnaround time

NDAS is written using an object-oriented approach with extensive use of an advanced development framework called the Actor Framework. In this approach, actors serve as the logic units of concurrent computation. In response to a message received, an actor can perform a specific task, send messages, and determine how to respond to messages. The major components of the NDAS software suite are as follows:

- NIRD - A central database which stores measurement configuration information for running the NDAS software,
- NOSS - A central system configuration interface for engineers to configure measurements in the NDAS software,
- NOPS - This function acquires, scales, and propagates all measurement data to client applications,
- NDIS - A client application for real-time data graphing, tabular displays, and event monitoring,
- NLOG - A client application for data logging and data file conversion.
- NGATE - A gateway between NDAS and downstream systems, converting customer data streams to NDAS data streams and vice versa.
- NCAL - This function performs short-term and long-term system calibrations.

Anticipated Benefits

Project Management

Program Manager:

Ramona E Travis

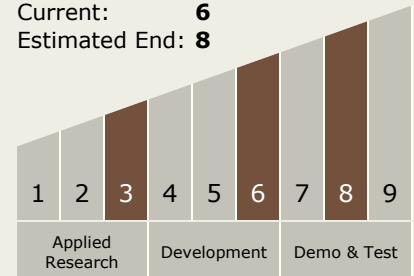**Project Manager:**

Joseph W Lacher

Principal Investigator:

Phillip W Hebert

Co-Investigator:

Alex C Elliot

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **8**

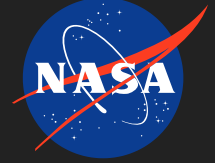| 1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  └ TX11.4 Information Processing
    └ TX11.4.2 Intelligent Data Understanding

TechPort

Printed on 12/06/2022
05:47 PM UTC

For more information and an accessible alternative, please visit:
https://techport.nasa.gov/view/32754

Page 2

Benefits to NASA funded missions include improving existing test operations real-time decision knowledge base which is critical for competitiveness of a propulsion systems test providers.

With the advent of the commercial space launch industry and NASA's more recent resumption of operation of SSC's large test facilities after thirty years of commercial entity control, there was no government owned software to operate the data acquisition system (DAS) at these facilities. This resulted in a need for a non-proprietary DAS software to support government and commercial testing. Therefore, NASA at Stennis Space Center set out to develop a suite of software to operate these systems which would alleviate the concerns of potential commercial customers in addition to reaping the benefits of owning such a software set.

NDAS changes the old paradigm by driving acquisition system consistency and by ensuring that the software systems are not owned by a specific company whose interests might not align with another customer. NDAS is developed and designed to replace the existing low-speed data and event monitoring systems, including the calibration system.

The legacy paradigm is to have different data acquisition system software in place at each test facility. This occurs because facilities come on-line at different times in their operating lifetimes. Engine or test article programs also begin and end at different times. This situation was driving fragmentation and inconsistency in the data acquisition system software in use at the test facilities. In many cases, proprietary engine customers would install and use their own software at a test stand. This could create a conflict of interest with other engine or test article customers.

NDAS software is designed for modularity and flexibility to minimize the software development effort for current and future data systems. In order to enable this adaptability, the system design incorporates the necessary functions to operate a rocket propulsion test facility DAS and its flexibility permits independence from the DAS hardware. An additional benefit of the software's architecture is its ability to easily migrate to other testing facilities, thus providing future commonality across Stennis. The software is portable without being specific to underlying hardware and facility configuration. The design combines a hardware abstraction layer (translation layer) with an innovative database structure along with the post-acquisition processing capability. This allows the software to be portable to multiple facilities with no modifications to the design and expected minimal modifications to the code. The system combines transducer tracking, in place calibrations, hardware configuration, data acquisition, logging and post-acquisition processing into a single software suite. Adapting the software to other Rocket Propulsion Test (RPT) Centers such as Marshall Space Flight Center (MSFC), White Sands, and Plum Brook Station would provide additional commonality and help reduce overall testing costs for NASA.
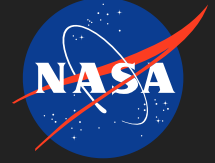
Ultimately, the software provides the government with unlimited rights and guarantees privacy of data to commercial entities.

Benefits to NASA unfunded missions & planned missions, include potential applications in other DAS configuration systems.

The software application is not designed for commercial applications but the potential exists for portable modular designed data acquisition system software if so desired.

Tech Port

Printed on 12/06/2022
05:47 PM UTC

For more information and an accessible alternative, please visit:
https://techport.nasa.gov/view/32754

Page 3

This software was intended for NASA initially but the purpose was also to provide software which could one day be transferred to universities and other government agencies.

The original goal for the NDAS software was to develop a common data acquisition software suite for NASA propulsion test centers, however, the software could one day be transferred to commercial organizations involved in any data acquisition endeavor. The NDAS software suite is best suited for large-scale, multiuser data acquisition systems with lower-speed (250 samples per second or below) acquisition requirements, but could be used for any generalized data acquisition system. The NDAS software suite is not designed specifically for the rocket engine testing domain. Additionally, the data visualization and recording components could be used for any applications where scientific measurement data is being used.

NDAS stands for NASA Data Acquisition System, which is a LabVIEW-based software application that is intended to be adaptable to any propulsion test stand or facility's Data Acquisition System (DAS). The intended Propulsion Test Facilities include; Stennis Space Center (SSC) in Mississippi, Marshall Space Flight Center (MSFC) in Huntsville, AL, PlumBrook Station (PBS) in Sandusky, OH, and White Sands Test Facility (WSTF), in Las Cruces, NM. In order to accomplish this adaptability, the system design needed to incorporate the necessary functions to operate a rocket propulsion test facility DAS and be flexible enough to be as independent of the DAS hardware as possible. Therefore, the design implements a Translation Layer, or NXLT, which translates the commands and data received from the DAS hardware components to the remainder of the system modules.

The software developed is of a modular architecture and is designed to be loadable based upon the underlying Data Acquisition System hardware configuration, for use at NASA Facilities. The software

is portable without being specific to underlying hardware and facility configuration. The design combines a hardware abstraction layer (translation layer) with an innovative database structure along with the post-acquisition processing capability. This allows the software to be portable to multiple facilities with no modifications to the design and expected minimal modifications to the code.

The system combines transducer tracking, in-place calibrations, hardware configuration, data acquisition, logging and post-acquisition processing into a single software suite.

Primary U.S. Work Locations and Key Partners
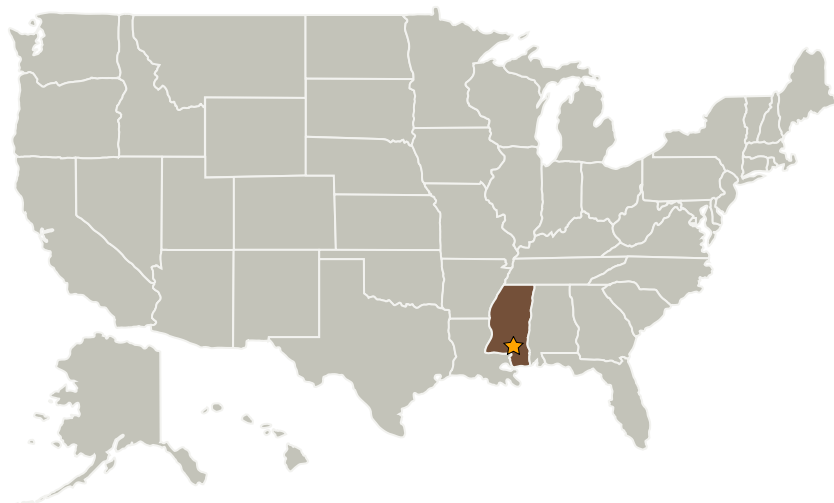
Organizations Performing Work	Role	Type	Location
⭐Stennis Space Center(SSC)	Lead Organization	NASA Center	Stennis Space Center, Mississippi

Primary U.S. Work Locations
Mississippi

Images

NDAS NASA Data Acquisition Software Suite – Version 2.0
Technology Transfer Logo
(https://techport.nasa.gov/image/16594)